ADVANCED DUCTED PROPFAN ANALYSIS CODE

State of the art flexible CFD tool to (primarily) investigate turbomachinery concepts ranging from low bypass ratio turbofans to propfans.

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CJM:sc.ADPAC.brochure

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ADPAC Capability Overview

Current version:	ADPAC07
External inflow:	On−axis or off−axis for configurations at angle of attack
Internal inlet:	Uniform (or plug) flow
	Distortion patterns with mixed radial and circumferential distributions of P_t & T_t
Boundary conditions:	Inviscid/viscous solid walls
	Porous walls with inflow or outflow
	Exit planes with constant static pressure, or radial equilibrium
Grid:	Multiple blocks
	Mixed C−, H−, I−, O− grids (some restrictions)
	Mixed Axi−Sym. 2D / 3D (single blade passage) / 3D (multiple blade passages)
	Externally stored as PLOT3D, multiblock, binary (cartesian)
Block coupling:	All BC's require a common face (no overlap or Chimera type BC's)
	Direct patch or interpolation for mis−matched grids with no relative movement
	Mixing plane (3D <−> 3D, 3D <−> 2D) or unsteady interpolation for blocks with relative movement

ADPAC Capability Overview

Block periodicity:	Cylindrical (turbomachinery) or cartesian (linear cascades, aircraft)
Flow paths:	Multiple, e.g. an engine with the core+bypass+external cowl flows
Solver algoithm:	Finite Volume Euler/Navier−Stokes
	4 or 5 stage Runge−Kutta explicit
	Arnone Implicit
	Multigrid acceleration
	Parallelized via message passing, APPL or PVM libraries
Turbulence models:	Baldwin−Lomax, Goldberg's k−R, Spalart−Allmaras (coming soon)
	Wall functions, restricted to the block with the wall
CPU/Memory use:	On a Cray YMP, roughly 48 words/grid point and 60 μs/iteration/grid point
Hardware Supported:	Cray DEC, HP(~), IBM, NCUBE, SGI, SUN workstations Win NT, LINUX on Intel platforms

ADPAC Documentation

Under contract NAS3−25270,
"Investigation of Advanced Counterrotation Blade Configuration Concepts for High Speed Turboprop Systems"

Report: Hall, E. J.; Delaney, R. A.; and Bettner, J. L.: Task I − Ducted Propfan Analysis Final Report. NASA CR−185217, April 1990.

Validation: *Single rotation propfan (SR−7A) and ducted fan (NASA 1.15) with axial inflow.*

Report: Hall, E. J.; Delaney, R. A.; and Bettner, J. L.:
Task II − Unsteady Ducted Propfan Analysis, Final Report. NASA CR−187106, May 1991.

Hall, E. J.; Delaney, R. A.; and Bettner, J. L.:
Task II − Unsteady Ducted Propfan Analysis, User's Manual. NASA CR−187105, May 1991.

Validation: *Single rotation propfan (SR−7A) and ducted fan (NASA 1.15) at angle of attack.*

Report: Hall, E. J.; Delaney, R. A.; and Bettner, J. L.: Investigation of Advanced Counterrotation Blade Configuration Concepts for High Speed Turboprop Systems; Task II − Unsteady Ducted Propfan Analysis, Final Report. NASA CR−187106, May 1991.

Validation: *Single rotation propfan (SR−7A) and ducted fan (NASA 1.15) at angle of attack.*

Report: Hall, E. J. and Delaney, R. A.:
Task V − Unsteady Counterrotation Ducted Propfan Analysis, Final Report. NASA CR−187126, January, 1993.

Hall, E. J. and Delaney, R. A.:
Task V − Unsteady Counterrotation Ducted Propfan Analysis, User's Manual. NASA CR−187125, January, 1993.

Validation: *Single rotation propfan (SR−7A) and ducted fan (NASA 1.15) at angle of attack.*

ADPAC Documentation

Under contract NAS3−25270,
"Investigation of Advanced Counterrotation Blade Configuration Concepts for High Speed Turboprop Systems"

Report: Hall, E. J.; Topp, D. A.; Heidegger, N. J.; and Delaney, R. A.:
Task VIII − Cooling Flow / Heat Transfer Analysis, Final Report. NASA CR−195359, September, 1994.

Hall, E. J.; Topp, D. A.; Heidegger, N. J.; and Delaney, R. A.:
Task VIII − Cooling Flow / Heat Transfer Analysis, User's Manual. NASA CR−195360, September, 1994.

Validation: *Cooled and uncooled vanes (Mark II, C3X) with the cooling flow modeled with porous surfaces and by direct gridding of the holes.*

Report: Hall, E. J.; Topp, D. A.; Heidegger, N. J.; and Delaney, R. A.:
Task VII − Endwall Treatment Inlet Flow Distortion Analysis, Final Report. NASA CR−195468 April, 1996.

Hall, E. J.; Topp, D. A.; Heidegger, N. J.; and Delaney, R. A.:
Task VII − Endwall Treatment Inlet Flow Distortion Analysis, User's Manual. NASA CR−195472 , April , 1996.

Validation: *UHB fan performance with and without casing treatments (circumferential, axial skewed, blade angle grooves; Allison recessed vane) for uniform and distorted (radial, circumferential, combination) inflow profiles.*

ADPAC Application/Validation Papers

MADIC ADPAC Certification Paper

Barber, T., Choi, D., McNulty, G., Hall, E., and Delaney, R.,"Preliminary Findings in Certification of ADPAC", AIAA Paper 94−2240,June, 1994.

Film Cooling Paper

Hall, Edward J., Topp, David A., and Delaney, Robert A., ‘‘Aerodynamic/Heat Transfer Analysis of Discrete Site Film−Cooled Turbine Airfoils’’, AIAA Paper 94−3070, 1994.

Casing Treatment Paper

Hall, Edward J., Crook, Andrew J., and Delaney, Robert A., ‘‘Aerodynamic Analysis of Compressor Casing Treatment with a 3−D Navier−Stokes Solver’’, AIAA Paper 94−2796, 1994.

Ducted Propfan Paper

Hall, Edward, J., and Delaney, Robert A., ‘‘3D Euler Analysis of Ducted Propfan Flowfields’’, AIAA Paper 90−3034−CP, 1990.

Ducted Propfan Angle of Attack Paper

Hall, Edward J., and Delaney, Robert A., ‘‘Time−Dependent Aerodynamic Analysis of Ducted and Unducted Propfans at Angle of Attack’’, ASME Paper 91−GT−190, 1991.

Parallel Computing Paper

Ecer, A., Akay, H. U., Kemle, W. B., Wang, H., Ercoskun, and Hall, E. J., ‘‘Parallel Computations of Fluid Dynamics Problems’’, Computer Methods in Applied Mechanis and Engineering, Vol. 112, pp. 91−108, 1994.